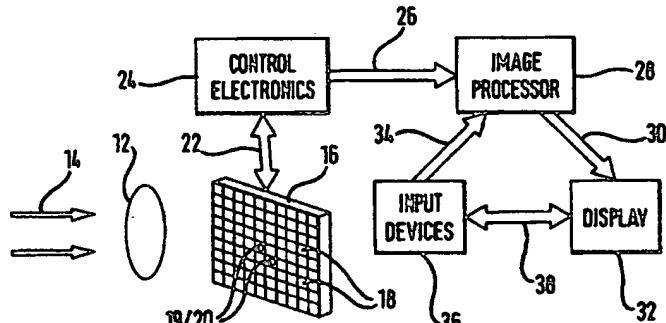




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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9410973.3	1 June 1994 (01.06.94)	GB	
9421289.1	21 October 1994 (21.10.94)	GB	
9502419.6	8 February 1995 (08.02.95)	GB	
9508294.7	24 April 1995 (24.04.95)	GB	
(71) Applicant (for all designated States except US): SIMAGE OY [FI/FI]; Tekniikantie 12, FIN-02150 Espoo (FI).			
(72) Inventors; and			
(75) Inventors/Applicants (for US only): ORAVA, Risto, Olavi [FI/FI]; Kyntelikuja 3, FIN-00730 Helsinki (FI). PYYHTIA, Jouni, Ilari [FI/FI]; Rasinkatu 20 A 84, FIN-01360 Vantaa (FI). SCHULMAN, Tom, Gunnar [FI/FI]; Kapteeninpolku 4 D 13, FIN-02430 Masala (FI). SARAKINOS, Miltiadis, Evangelos [GR/CH]; 65, rue de Carouge, CH-1205 Geneva (CH). SPARTIOTIS, Konstantinos, Evangelos [GR/FI]; Kulmakatu 8 B, FIN-00170 Helsinki (FI).			
(74) Agent: HARRIS, Ian, Richard; D. Young & Co., 21 New Fetter Lane, London EC4A 1DA (GB).			

(54) Title: IMAGING DEVICES, SYSTEMS AND METHODS



## (57) Abstract

An imaging device comprises a semiconductor substrate (16) including an array of pixel cells. Each pixel cell comprising an individually addressable pixel circuit (18) for accumulating charge resulting from radiation incident on a pixel detector. The pixel circuit and the pixel detector can either be implemented on a single substrate, or on two substrates bonded together. The charge storage device can be a transistor, for example one of a pair of FETs connected as a cascade amplification stage. An imaging plane can be made up of one imaging device or a plurality of imaging devices tiled to form a mosaic. The imaging devices may be configured as a slot for certain applications, the slit or slot being scanned over the imaging plane. Control electronics (24) can include addressing logic for addressing individual pixel circuits for reading accumulated charge from the pixel circuits. Imaging optimisation can be achieved by determining maximum and minimum charge values for pixels for display, assigning extreme grey scale or colour values to the maximum and minimum charge values and allocating grey scale or colour values to an individual pixel according to a sliding scale between the extreme values. Scattered radiation can be detected and discarded by comparing the detected pixel value to a threshold value related to a minimum detected charge value expected for directly incident radiation and discarding detected pixel values less than said threshold value.

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## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/EP 95/02056A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 H04N3/15 H04N5/32 G01T1/29

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 H04N G01T

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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A	see column 1, line 23 - line 58 see column 2, line 50 - column 3, line 38 see column 3, line 68 - column 8, line 23 see column 9, line 7 - line 51 see figures 1,2,2A ---	
Y	EP,A,0 300 365 (TECHNION RES & DEV FOUNDATION) 25 January 1989 see column 3, line 50 - column 4, line 44 see column 5, line 44 - column 12, line 26 see figures 1-3,5 ---	1-8,20 -/-

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

## \* Special categories of cited documents :

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- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

\*&amp;\* document member of the same patent family

7

Date of the actual completion of the international search	Date of mailing of the international search report
27 November 1995	15.12.95

Name and mailing address of the ISA  
European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl,  
Fax (+ 31-70) 340-3016

Authorized officer

Wentzel, J

## INTERNATIONAL SEARCH REPORT

Int. Jnl Application No
PCT/EP 95/02056

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Int. Application No

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International Application No

PCT/EP 95/02056

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Inte. onal Application No

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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**INTERNATIONAL SEARCH REPORT**

International application No.

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**Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.: because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3.  Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

**see continuing sheet**

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
  
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
  
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

1-54, 57-60

  
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest** The additional search fees were accompanied by the applicant's protest. No protest accompanied the payment of additional search fees.

The subject-matter of independent claim 1 is known. Document US-A-5 135 420 discloses an imaging device for imaging radiation ( see fig 1 and col. 9, line 25-51), said imaging device comprises an array of pixel cells ( see fig. 1 or 2, reference number 10) having a semiconductor substrate ( see col. 5, line 16 to 25) including an array of pixel detectors ( see fig. 2 or 2a; reference numbers 12) which generate charge in response to incident radiation and a corresponding array of pixel circuits ( see fig. 2 reference number 14), each pixel circuit being associated with a respective pixel detector for accumulating charge resulting from radiation incident on said pixel detector, said pixel circuits being individually addressable and comprising circuitry for accumulating charge from successive radiation hits on the respective pixel detectors ( see col 4, line 9 to col.7, line 46 and col. 9, line 7 to 24).

Furthermore, document US-A-4 454 117 shows an imaging device for imaging radiation, having all but one of the technical features ( see figure 2 and associated text) as set out in claim 1. The missing feature is that the pixel circuits being individually addressable. The last mentioned US Document discloses only row addressable pixel circuits. Nevertheless imaging devices having individual addressable pixel circuits are well known in the art, see for example EP-A- 300 365, fig 2,3,5 and associated text. Therefore, it appears that the person skilled in the art will easily obtain an imaging device according to the subject-matter of claim 1 by using a well-known design option without the exercise of an inventive skill.

Claims 2, 10, 22, 32, 36, 40, 42, 43 and 58 are all directly dependent on claim 1, the subject-matter of which is not new. Furthermore, the claims 53 to 55 has to be regarded as independent, since the use of the expression " for example" appears to have no limiting effect at all. The features added by each of these claims differs from that of the features added by the others without there being any unifying concept common to all. Consequently, the requisite unity of the invention no longer exists ( Rule 13.1 PCT), since the claims 1 to 60 are no longer linked by a common special technical feature as required in Rule 13.2 PCT. The subject-matter of the application is therefore divided in the following inventions.

The division into the single inventions was mainly based on technical aspects, since the structure of the claims does not fulfil the requirements of Rule 6.4 a) PCT.

**1.Invention:** Claims 1, 2-9,16-21, 24, 32, 57,59,60

Imaging device for radiation imaging having an array of pixel cells, said pixel cells being formed by a detector and an individual addressable pixel circuit; method of imaging with said device and use of said device in imaging applications;

**2.Invention:** Claims 10-15

Imaging device having electrical resistance means to separate electrical pixel cells;

**3.Invention:** Claims 22,23,50-52 and 58 ( as far as depending on claim 50)

Slit or slot imaging device comprised in an imaging system and operated by a method to minimize the effects of scattered radiation;

**4.Invention:** Claims 25-31,33-35,53 and claims 47-49,58 ( as far as they depend on any of claims 33-35)

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Imaging device having control electronics for addressing, resetting, reading and digitizing the charge signals accumulated in individual pixel circuits and for allocating grey scale or colour values to said charge values

5.Invention: Claims 36-46 and claims 47-49 and 58 ( as far as they depend on any of claims 36- 46)

Imaging system having a plurality of imaging devices arranged in a planar or at least partial tubular mosaic;

6.Invention: Claim 54

A method for automatically correcting a defect pixel value produced by an imaging device; and

7.Invention: Claim 55,56

A method for automatically optimising imaging by selecting an image device with the best properties.

It is also to be remarked that imaging system having an imaging device, control electronics, analog-to-digital conversion, a processor and a display are well known in the art ( see for example WO-A-93/14418; fig 4 and associated text). Therefore these feature cannot be regarded as special technical feature in sense of Rule 13.2 PCT.

The search for the 6th Invention was performed according to the current practice at the EPO, since no significant extra effort had to be spent ( see also PCT Search Guidelines Chapter VII paragraph 12).

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 95/02056

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PCT/EP 95/02056

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